

As a practical matter, the Commission could proceed with its provisional benchmark model to initialize rates for September 1993, while concurrently pursuing improvements in the empirical specification of the model. The improved version could then be used to reset initial rates at some specified future date (say September 1994).<sup>13</sup>

On the selection of appropriate yardsticks, the price cap which I propose is based on competitive, unregulated cable systems as the yardstick both for input prices and TFP. By contrast, the price cap provisionally adopted by the Commission uses more aggregate (economy-wide) targets which are less directly comparable to regulated cable systems. The next section and the appendix discuss and compare these two approaches more fully.

## **Section 2. Price Cap Design**

The basic formulation of the price cap that incorporates incentives for (technical) efficiency can be written as

$$(1) \quad dp_m = dw_t - dTFP_t$$

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<sup>13</sup> To avoid inducing strategic responses to this procedure by cable operators, the revised benchmark model should be based on data ending in 1993. Adjustment of price levels for the lag between 1993 and the benchmark revision date could be made on the basis of the GNPPI for that year only.

where  $dp$  and  $dw$  represent the rates of change in composite (weighted average) output prices and input prices, and  $dTFP$  denotes the rate of growth in TFP.<sup>14</sup> The subscripts "m" and "t" denote the regulated monopoly system ("monopoly") and the selected yardstick ("target"), respectively. This equation sets the (maximum) output price growth of regulated cable systems equal to the difference between the rates of growth in input prices and TFP for the chosen yardstick. If the yardstick were the same as the regulated monopoly, this output price change would just compensate the monopoly for changes in its real cost of production (as required by the *compensation principle*). This would not provide incentives for technical efficiency. As discussed in Section 1, incentives are provided by using external yardsticks for input price and TFP growth in Equation (1). The choice of appropriate yardsticks to generate these incentives depends on the structure of the industry and the availability of information. Two alternative approaches are outlined here.

The first price cap specification is the one used by the Commission for Interexchange Carriers ("IXCs") and LECs, and provisionally adopted for cable. This specification is based on the assumption that composite input price growth at the economy-wide level ( $dw_e$ ) is a reasonable yardstick for regulated cable systems. There is no publicly available, annual index of composite input prices at the aggregate

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<sup>14</sup> A complete derivation of the equations discussed is provided in the appendix.

level.<sup>15</sup> However, one can use the sum of output price inflation ( $dp_a$ ) and TFP growth at the economy-wide level as an indirect measure of aggregate input price inflation.<sup>16</sup>

This allows one to reformulate the basic price cap in the following way:

$$(2) \quad dp_m = dp_a - x \quad \text{where } x = dTFP_i - dTFP_a$$

In this formulation, output prices are allowed to change at the rate of aggregate output price inflation (e.g., the GNPPI) minus a productivity offset or "x-factor" that represents the *differential* between the yardstick and economy-wide rates of TFP growth. The reason that the x-factor is a differential is that the aggregate inflation term ( $dp_a$ ) already reflects aggregate TFP growth.

Equation (2) is the form of price cap used by the Commission for IXC's and LEC's, and provisionally adopted for cable. However, this formulation is not the best available approach to solving the "yardstick" problem for cable regulation. There are two reasons for this conclusion. First, there remains the difficult problem of setting a sensible value for the x-factor and adjusting it over time (see Section 4 for discussion). In the case of telephony regulation, this issue was somewhat less problematic because there was a substantial body of empirical evidence on TFP growth in that industry. Similar hard evidence is not yet available for the cable industry.

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<sup>15</sup> The composite index refers to the cost-share weighted average of component input price growth (see the appendix). Data are available at the economy wide level for selected input prices but not for a composite input price index.

<sup>16</sup> Specifically, one can write  $dw_a = dp_a + dTFP_a$ , where the subscript denotes the (aggregate) economy. Substituting for  $dw_i$  into Equation (1) yields the result in the text. See the appendix for details.

The second, and more important, reason is that there is a much better yardstick available for regulated cable systems than the economy-wide metric embodied in Equation (2). The cable industry consists of both monopoly systems and competitive systems providing essentially the same set of services. The most natural and appropriate approach is to use competitive cable systems as the yardsticks for input prices and TFP for regulated systems.<sup>17</sup> However, it is not even necessary to construct separate yardsticks for input prices and TFP. Instead, my recommendation is to base the price cap for monopoly cable systems directly on the *output prices for competitive systems*. Use of this output price yardstick obviates the need to have separate yardsticks for the growth in input prices and TFP because both factors are reflected in movements in competitive cable output prices.

Using this yardstick, the original price cap in Equation (1) becomes

$$(3) \quad dp_m = dw_c - dTFP_c$$

where the subscript "c" denotes competitive cable systems. This equation simplifies even further because the right hand side is simply the rate of change in competitive cable prices,  $dp_c$ . Therefore, the entire price cap for regulated cable systems is reduced to using the change in the output price of competitive cable systems. That is,

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<sup>17</sup> This approach cannot be used for LECs at the present time because, while there is competition in selected telephony services, the industry does not yet contain full-service, competitive companies. The proposed approach may be applicable to LECs at some future date, especially as the telephony and cable industries converge.

(4)  $dp_m = dp_c$

This is the price cap formulation which I recommend to the Commission. This proposed price cap is derived from the same economic principles as the other versions, but is far simpler and more direct. Namely, the price change for monopoly cable systems is limited by the price change in competitive cable areas.<sup>18</sup>

As indicated earlier, this formulation has two major advantages: (i) it is based on the most appropriate available yardstick, i.e., competitive cable systems, for regulated cable systems, and (ii) it eliminates the need to construct separate measures of input price and TFP growth for the (yardstick) competitive systems because their *output* price growth already reflects both factors.

The proposed price cap can be implemented easily. To construct the yardstick, I recommend that competitive systems be defined as all multichannel video providers meeting the criteria for "effective competition" specified in the Cable Act,<sup>19</sup> except low penetration systems. Low penetration systems should be excluded from the yardstick, because in my view, the evidence clearly shows that such areas are not characterized

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<sup>18</sup> If there were good reason to believe that the TFP growth potential for monopoly systems differs from competitive systems, the price cap could be modified to reflect this difference as follows:  $dp_m = dp_c - [dTFP_m - dTFP_c]$ . In this case, the Commission would again have to determine the appropriate productivity offset in brackets. There is no evidentiary basis or strong *a priori* reason to make this adjustment at this stage.

<sup>19</sup> When a cable system first shifts into the "effectively competitive" category, according to the criteria in the Cable Act, it may be reasonable to expect some transitional disequilibrium pricing behavior. Therefore, I suggest that such systems be included in the competitive yardstick calculation only after one or two years.

by effective competition.<sup>20</sup> The Commission should apply this proposed price cap to both basic and enhanced basic services to maintain "tier neutrality," as under the provisional price cap.<sup>21</sup> The only information the Commission needs to implement the price cap are the prices of *competitive* cable systems. These data could be gathered annually from all (or a random sample of) competitive cable operators without substantial regulatory burden.<sup>22</sup>

The proposed competitive price cap satisfies the central legislative directives in the Cable Act and has several important advantages over the price cap provisionally adopted by the Commission. First, the Cable Act expresses Congressional policy to rely on the marketplace to the maximum extent feasible to promote programming diversity (Sec.2, Para.(b)), and to use the competitive standard for determining rates for monopoly cable systems (Sec.3, Para.(b)). The proposed price cap formally embodies precisely that standard in the mechanism to regulate monopoly rates. Second, the proposed price cap is simple to implement and minimizes the administrative burdens on cable operators, local franchising authorities, and the

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<sup>20</sup> Joint Comments of Bell Atlantic, GTE, and NYNEX, MM 92-266, Affidavit of Thomas Hazlett, June 17, 1993, pp. 11-12.

<sup>21</sup> It is important to maintain tier-neutrality for two reasons. First, it prevents monopoly cable operators from circumventing regulation by recategorizing services. Second, tier-neutrality very substantially reduces the potential for cross-subsidization. Under a price cap, cable operators cannot raise prices to monopoly levels for some services to recoup losses from underpricing other services. There still remains some limited potential to use unregulated services for this purpose.

<sup>22</sup> The Commission has statutory authority to compile and publish basic cable and other programming service rates for competitive and regulated monopoly systems (Cable Act, Sec.3, Para.(k)).

Commission, as required by the Cable Act (Sec.3, Para.(b)).<sup>23</sup> Third, the proposed price cap eliminates the need to determine an appropriate productivity offset for the cable industry relative to the economy at large, the "x-factor."<sup>24</sup> Finally, there is no need for any procedure to adjust a productivity offset over time because competitive output prices automatically reflect TFP for the (yardstick) competitive cable systems.

### **Section 3. Potential Criticisms of the Proposed Price Cap**

This section addresses potential criticisms of the proposed price cap based on output prices for competitive cable systems. The first criticism is that the average cost per channel for monopoly systems may systematically differ from competitive systems, and hence competitive cable rates are not a useful yardstick. Such cost differences may arise from systematic variations in input prices, embedded technology and demographic characteristics. To address this criticism, one must carefully distinguish between the *initial price level* (the benchmark) and the *price cap for adjusting prices*. The benchmark procedure is used to set initial price levels for monopoly cable systems. If there are unique features of monopoly systems that affect their costs, they should be incorporated in the determination of the benchmark. The econometric model used by the Commission to determine provisional benchmarks controls for

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<sup>23</sup> To ensure that this simplification of the regulatory process is realized, it is also important that appropriate restrictions on cost of service relief be adopted. (See the discussion of the earnings floor mechanism in Section 1.)

<sup>24</sup> This need arises with the proposed price cap only if monopoly and competitive cable systems have systematically different TFP growth rates. See note 17.

measures of scale but not other potentially relevant characteristics.<sup>25</sup> As indicated earlier, I do think it is advisable for the Commission to improve its benchmark. To accomplish this, the Commission should require both regulated and competitive cable companies to submit information that can be used to incorporate more franchise and system characteristics in the benchmark methodology. In any event, putative differences in the *level* of average cost relate solely to the benchmark procedure and have nothing to do with the design of the price cap which adjusts prices over time. Competitive system prices remain the best yardstick for the price cap.

A second criticism is that monopoly cable systems have less potential for TFP growth than competitive systems, so that the proposed price cap will penalize regulated monopoly operators. There are three points to be made in response. First, since both monopoly and competitive systems draw from the same pool of technology and produce (or can produce) similar service offerings, the validity of this claim is dubious. Second, it should be emphasized that *any* price cap that provides incentives

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<sup>25</sup> Specifically, the model uses three variables: the number of subscribers, channels, and satellite sources for programming. For discussion on this issue see Attachment to Viacom International Inc., Petition for Reconsideration and Clarification, June 21, 1993, James Dertouzos and Steven Wildman, "Regulatory Benchmarks for Cable Rates: A Review of the FCC Methodology" (June 1993). For empirical studies of the determinants of cable prices more generally see Stanford Levin and John Meisel, "Cable Television and Competition - Theory, Evidence and Policy," Telecommunications Policy, December 1991, pp. 519-528; Robert Rubinovitz, "Market Power and Price Increases for Basic Cable Services Since Deregulation," Rand Jo. of Economics, Vol. 24, No. 1, Spring '93, pp. 1-18; Willis Emmons and Robin Prager, "The Effects of Market Structure and Ownership on Prices and Service Offerings of U.S. Cable Television Industry," paper presented at Western Economics Association Conference, June 22, 1993; and John Mayo and Yasugi Orsuka, "Demand, Pricing, and Regulations: Evidence from the Cable TV Industry," Rand Jo. of Economics, Vol. 22, No. 3, Autumn '91, pp. 396-410.



for efficient operation must decouple the company's prices from its costs by utilizing an external yardstick for input prices and TFP. The real issue in designing the price cap is to select the best available yardstick and to incorporate adequate safeguards to accommodate special circumstances without undermining the efficiency incentives. The price cap provisionally adopted by the Commission is based on an economy-wide yardstick for input price growth. In my view, there is no doubt that competitive cable systems are a much better yardstick for regulated monopoly systems than this economy-wide measure. The third point is the issue of safeguards. I have recommended that the Commission adopt an earnings floor mechanism that would allow full cost of service review for cases of protracted substandard earnings (see Section 1). I believe this safeguard will adequately protect regulated cable operators without damaging the important incentives provided by the basic price cap.

A third criticism to the proposed price cap is that, contrary to the objectives embodied in the Cable Act, it will not promote investment in infrastructure and programming diversity. This criticism lacks both theoretical and empirical foundation.<sup>26</sup> Equally important, it is inconsistent with the clear preference for competition expressed by Congress in the Cable Act. By exempting "effectively competitive" systems from regulation, Congress decided in favor of a competitive standard to judge the economic performance of cable systems, including prices, programming and private infrastructure investment. The proposed price cap formally embodies this standard in the mechanism to regulate monopoly rates.

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<sup>26</sup> Researchers who have empirically studied the determinants of program quality have reached mixed conclusions about the effects of deregulation and competition. See, e.g., Emmons and Prager, and Rabinovitz, id.

There is an important corollary to this point. If the proposed price cap were adopted, there would be no basis for the provisional decision by the Commission to treat programming costs (for Multiple System Operator ("MSO")-unaffiliated cable operators) as "external costs" and to allow automatic recovery through rates (MM Docket 92-266, para. 251). The Commission reached this conclusion on the basis of the finding in the record that programming costs increased at a rate exceeding the *overall rate of inflation*. The choice of yardstick underlying the price cap is key here. The Commission's provisional price cap is based on an aggregate output price index (GNPPI), so that special treatment of programming costs may have been warranted. However, output prices for competitive systems will already reflect programming costs for competitive cable systems and, similarly, the rate of change of output prices will capture changes in programming costs. Therefore, a price cap based on these competitive output prices obviates the need for special treatment of programming costs for regulated monopoly systems. This is an important advantage of the proposed price cap because programming costs are a large component (around 35%) of total cable operating expenses,<sup>27</sup> and therefore need to be subjected to the efficiency incentives provided by the price cap.<sup>28</sup>

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<sup>27</sup> Based on data for a sample of large MSOs in 1992, cable programming costs were about 38% of total operating expense for east coast systems and 34% for west coast systems. Estimates provided by GTE Laboratories, Inc.

<sup>28</sup> The same argument holds for investments in system improvement and expansion. These should not be treated as "external" under the proposed price cap. The Commission has ruled such costs ineligible for external treatment under the provisional price cap (Rate Regulation Order, MM Docket No. 92-266, para. 256, n.608).

#### **Section 4. Setting the X-Factor for the Provisional Price Cap**

As indicated earlier, a distinct advantage of the proposed price cap based on competitive system prices is that it does not require an x-factor. However, if the Commission decides to go forward with a price cap based on GNPPI ("provisional price cap"), it must address this issue. The Commission solicits comment on how to determine the appropriate x-factor for cable price cap regulation (Notice, Para. 85). It is important to clarify the appropriate concept of productivity in the context of the provisional price cap, before any measurement issues are discussed. The productivity adjustment factor is designed to reflect the differential between the rate of growth of *total factor productivity* for the cable industry and the economy as a whole. It is entirely wrong to use any measure of partial productivity (e.g., labor productivity) to set the x-factor. All such measures are incompatible with the economic foundations of the price cap and fail to satisfy the basic compensation principle discussed in Section 2.<sup>29</sup>

In MM Docket No. 92-266, the Commission provisionally adopted an x-factor of zero. This was justified partly on the claim that productivity gains resulting from increased cable system capacity are reflected in the benchmark procedure, which sets per channel rates that decline with the number of channels and subscribers (see also Notice, footnote 97, p. 46). This reasoning is incorrect because it does not distinguish

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<sup>29</sup> See the technical appendix and Section 2 in this statement for a more detailed discussion. Partial productivity measures have been used to compare efficiency levels of in the telephone and cable industries (see Continental Cablevision Comments in MM Docket No. 92-266, Appendix C, pp. 11-12). The Commission itself, in Para. 84 of the Notice, hints at the possibility of using partial productivity measures to set the x-factor. This approach definitely should be rejected.

between differences in the level of unit cost across systems due to capacity differences, and changes in unit cost over time for any given system due to growth in capacity. The benchmark procedure involves setting the initial price for regulated cable systems according to some measures of the initial system size which are presumed to affect unit cost - that is, locating each cable system at the "right" point along the declining unit cost curve. This procedure only captures (at best) the effect of scale economies on the *initial level* of competitive prices. However, the growth in TFP due to scale economies is realized when system capacity *expands* - that is, cost reductions arising from each system moving down along the unit cost curve.<sup>30</sup> These are entirely separate issues. The benchmark relates to the initial level of TFP (unit cost), whereas the productivity offset relates to the growth in TFP. Therefore, the benchmark procedure itself provides no support for setting a zero productivity offset.

If the Commission chooses to retain the provisional price cap, it should definitely impose a positive productivity offset. Development and deployment of advanced computer and communications technology in the cable industry are providing more efficient capital inputs and opportunities for system reconfiguration to produce further productivity gains.<sup>31</sup> To my knowledge, there are no published studies of TFP growth for the cable industry during the last decade. Even in the absence of

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<sup>30</sup> Productivity gains due to technology changes are reflected by downward shifts in the cost curve itself.

<sup>31</sup> For example, replacement of coaxial by fiber reduces amplification-transportation costs, reduces outage frequency, improves reception quality, and enhances ability to increase bandwidth and hence program capacity. Addressable CPE provides functionality that allows for service reconfiguration and reduces customer service response time.

such studies, however, it does not meet the common sense rule to assume that the potential for TFP growth for the cable industry is the same as for the economy at large, which includes both low and high technology industries. The strong presumption should be in favor of a positive productivity offset of roughly the same magnitude as technologically similar industries.

No comparison with other industries will be above criticism. Nonetheless, in my opinion the most defensible approach at this stage is to use the TFP performance of LECs as the yardstick for monopoly cable operators. There is already very substantial similarity in the underlying technology (capital goods) in the two industries, and increasing convergence in terms of technological capability and potential service provision. The extensive use of fiber optics for transmission from the head end to the neighborhood, switch links among head ends, addressable converters, and digital compression technology all blur the distinction between cable and telephony in terms of providing two-way voice and data communication.<sup>32</sup>

On the basis of these considerations, I recommend that the Commission set the x-factor at 3.3 percent for the provisional price cap. Until direct studies of TFP growth for the cable industry are available, evaluated and substantiated, the Commission should continue to use the LEC productivity offset for the cable price cap.

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<sup>32</sup> For example, the Cable Loop Carrier-500 system developed by AT&T Network Systems and Antec (U.S. trials planned for late 1993), as announced, will allow telephone and cable companies to deliver both telephone and video services over the same fiber and coaxial cable networks now used to distribute cable TV. Communications Daily, July 28, 1993, p. 7. U S West and Time Warner intend to deploy telephone services over their cable TV facilities. Petition of Time Warner Entertainment Company, L.P. and U S West Communications, Inc. for Temporary Waiver of Section 63.54 of the Commission's Rules, May 26, 1993, at page 3.

Some commentators suggest that there are "embedded inefficiencies" in the telephone industry (and not in cable) which justify a lower productivity offset for cable. This conclusion should be rejected for two reasons. First, there is no direct evidence in the record on TFP growth in the telephone and cable industries to support the claim.<sup>33</sup> In fact, LECs have been making considerable efforts to streamline and restructure both in response to regulatory reform at the state and federal level and in anticipation of intense competition from "full service network" cable companies and other communications firms. Second, the Cable Act applies regulation only to *monopoly* cable systems, not competitive operators. These monopoly cable systems have not been subject to the normal competitive pressures for efficient operations and may themselves have considerable scope for technical efficiency gains.

Programming costs are also cited as a reason not to use LEC productivity growth as the yardstick for cable companies. There is evidence in the record that programming costs rose faster than aggregate inflation, but this is not sufficient basis for rejecting the LEC productivity yardstick. It must be remembered that the growth of programming *inputs* (costs) produced a correspondingly rapid expansion of program diversity which is one important dimension of the *output* of cable companies. Therefore, the rapid rise in programming costs may well have contributed to faster

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<sup>33</sup> Evidence based on measures of partial productivity (e.g., employees per access line) is not germane and cannot be used to establish the claim. For an example of such evidence, see supra note 28.

rather than slower TFP growth for the cable industry.<sup>34</sup> Until direct empirical studies of TFP growth (encompassing all relevant dimensions of output including program diversity) are available, no conclusion can be drawn with respect to how program costs have affected cable productivity. Until then, I continue to recommend the use of the LEC productivity offset as the yardstick for the cable price cap.

## **Conclusion**

This statement discusses the economic foundations for proper design of price caps and makes specific recommendations in the context of cable regulation. Three central recommendations are developed. First, I propose a price cap that uses the output prices for competitive (unregulated) cable systems to constrain monopoly cable rates. This formulation of the price cap embodies the Congressional directive to rely on the competitive market standard to the maximum extent feasible. Moreover, this price cap eliminates the need to determine a productivity offset for the cable industry, provides appropriate incentives for efficient operation, meets the objective of regulatory simplification, and can be easily implemented. However, in the event that the Commission decides to retain the price cap provisionally adopted in MM 92-266, I

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<sup>34</sup> The rapid rise in programming costs may have been partly a short run phenomenon, caused by sharp increases in the demand for programming by cable companies in the face of relatively inelastic short run program supply. There is some anecdotal evidence consistent with this hypothesis. In bargaining on retransmission versus must-carry, some programmers (e.g., Fox, NBC, and Capital/ABC) have recently opted for broadcast must-carry with the proviso that cable companies accept their other programming channels. Communications Daily, Aug. 1, 1993, p. 5 and Aug. 19, 1993, p. 4. This suggests excess supply, not excess demand for programming.

recommend that the x-factor be set at the same level (3.3 percent) as the price cap for LECs pending availability and evaluation of cable specific TFP studies. Second, I recommend that the Commission very strictly limit the use of cost of service hearings for rate relief, regardless of the price cap selected, by adopting an earnings floor mechanism as the safeguard to protect regulated cable operators from prolonged low earnings. Finally, I recommend that the Commission improve the benchmark procedure by including a fuller set of cost-determining characteristics in the econometric model. Benchmark cable rates should then be reset on the basis of the revised model and subjected to the recommended competitive price cap going forward.



## **Appendix. Technical Derivation of Price Cap Mechanism**

This appendix presents the technical derivation of the proposed price cap. The analysis is conducted for the general case of a multiple input-multiple output firm (specialization to the single product firm is straightforward). It should be noted that the derivation also holds for an industry or the economy as a whole, under the stated assumption, by suitably redefining the unit of analysis.

In Section A.1, I derive the price cap formula without reference to the important incentive problem of how to promote productivity growth and economical input use. These critical incentive issues are introduced in Section A.2 and the final proposed revenue cap incorporating the necessary modifications is presented.

### **Section A.1. Baseline Price Cap**

Consider a firm which produces some set of  $N$  outputs using  $M$  inputs. Denote the outputs as  $y_i$  and the inputs as  $x_j$  where  $(i=1,...,N)$  and  $(j=1,...,M)$ . Note that the list of inputs contains all factors used in the production process, including capital. Let  $p_i$  represent the unit output price for  $y_i$  and  $w_j$  denote the unit input price for  $x_j$ . Define

total revenues as  $R = \sum_{i=1}^N p_i y_i$  and total costs as  $C = \sum_{j=1}^M w_j x_j$ .

The only assumption required for this analysis is that the level of supernormal profits (above the opportunity cost of capital) the firm earns is some constant proportion of its revenues. Letting  $\pi$  denote the level of supernormal profits,

$$(1) \quad \pi = f R \quad \text{for any constant } f \geq 0$$

This is a mild assumption. It does not impose any particular profit rate (the special case of normal profits is  $f = 0$ ). Using the definition  $\pi = R - C$ , Equation (1) can be rewritten as:

$$(2) \quad (1-f) R = C$$

Substituting the expressions for revenues and costs, Equation (2) becomes:

$$(3) \quad (1-f) \sum_i p_i y_i = \sum_i w_i x_i$$

Totally differentiating Equation (3) with respect to time yields:

$$(4) \quad (1-f) \left[ \sum_i p_i \dot{y}_i + \sum_i \dot{p}_i y_i \right] = \sum_i w_i \dot{x}_i + \sum_i \dot{w}_i x_i$$

where a dot over the term represents the derivative of that variable with respect to time. Dividing by Equation (2), I can rewrite Equation (4) in terms of rates of growth of the variables in the following way:

$$(5) \quad \sum_i v_i \dot{p}_i + \sum_i v_i \dot{y}_i = \sum_j s_j \dot{w}_j + \sum_j s_j \dot{x}_j$$

where the prefix "d" denotes a rate of growth (e.g.,  $\dot{p} = \dot{p}/p$ ). Also,  $v_i = p_i y_i / R$  is the revenue share of output  $i$  and  $s_j = w_j x_j / C$  is the cost share of input  $j$ . Rearranging Equation (5) yields:

$$(6) \quad \sum_i v_i \dot{p}_i = \sum_j s_j \dot{w}_j - [\sum_i v_i \dot{y}_i - \sum_j s_j \dot{x}_j]$$

Writing Equation (6) in simplified notation,

$$(7) \quad \dot{p} = \dot{w} - [\dot{y} - \dot{x}]$$

The term  $\dot{p}$  is the (revenue-share) weighted average rate of growth of output prices, which I refer to as *composite output price growth*. The term  $\dot{w}$  is the (cost-share) weighted average rate of growth of input prices, or *composite input price*

*growth*. The terms  $dy$  and  $dx$  represent the weighted average rates of growth of output and input quantities, respectively. Since the level of Total Factor Productivity (TFP) is defined as the ratio of the quantity of composite (weighted average) output to composite input, the expression  $dy - dx$  is simply the rate of growth of TFP, denoted  $dTFP$ . Therefore,

$$(8) \quad dp = dw - dTFP$$

Equation (8) summarizes the baseline price cap formula, ignoring the incentive features which are incorporated in Section A.2. This equation denotes that output price growth should equal input price growth minus the rate of growth of TFP, where all growth rates are constructed as appropriate weighted averages. The price changes described by this equation would just compensate the company for changes in its real cost of production. This is referred to in the text as the "*compensation principle*."

Note that this derivation does *not* require any assumption about cost minimization, output prices based on marginal cost, or the absence of economies of scale or scope in the production function. These additional assumptions may be required if one wishes to interpret  $dTFP$  only as the shift in the underlying production frontier facing the firm ("technical change"). This is the interpretation commonly given in the economics literature. However, it is important to emphasize that in the context of the price cap, the role of the TFP term is to capture *all* changes in the firm's production cost other than those due to input price changes, including both cost

savings due to economies of scale and scope as well as shifts in the production frontier.

## **Section A.2. Incorporating Incentives Features**

**Version 1.** In the baseline formulation in Equation (8), the company's allowable growth in output price is related directly to the change in its input prices and inversely to its TFP growth. This formulation does not provide any incentives to the regulated company to minimize production costs (e.g. by economical input choice) or to generate long term productivity growth. To provide such incentives, it is necessary to replace the company-specific input price and TFP components in the price cap with *external yardsticks or targets* that are not affected by the company's own decisions and performance. The choice of appropriate yardsticks for input price and TFP growth depends heavily on the structure of the industry and the type of information that is available.

Let the subscripts "m" and "t" denote the regulated monopoly supplier (hereafter, monopolist) and the chosen external yardstick ("target"), respectively. Then the general form of the price cap with incentive features is:

$$(9) \quad dp_m = dw_t - dTFP_t$$

The use of yardsticks in the price cap provides incentives to economize on inputs (restrain input price growth) and to promote TFP growth. For example, if the monopolist is able to exceed the target TFP growth, then the output price change

allowed by the price cap exceeds the level necessary to compensate the company for the change in its cost of production [the latter is given by Equation (8)]. The price cap thereby generates an increase in net earnings for the regulated company, and it is this reward which represents the incentive to increase productivity in the first place.

Conversely, failure to achieve the target TFP growth penalizes the monopolist. A symmetric argument holds for input prices. Because efforts by the monopolist to restrain input costs beyond the change reflected in the target do not affect the allowed price change under a price cap based on external yardsticks, there is an incentive to pursue such efforts and a penalty for unsuccessful performance.

**Version 2.** The price cap in Equation (9) above requires information on suitable yardsticks for both input prices and TFP growth. The price cap can be reformulated in a way that eliminates the need for a direct measure of input price changes. This reformulation requires the additional assumption that input price growth at the economy-wide level is a reasonable yardstick as assumed by the Commission's "provisional price cap." However, because there is no available index of composite input prices at the aggregate level, one must measure it indirectly. To do so, we exploit the relationship between the rates of growth of output prices, input prices, and

TFP at the economy-wide level.<sup>1</sup> Letting the subscript "a" denote the (aggregate) economy, one can write this relationship:

$$(10) \quad dp_a = dw_a - dTFP_a$$

Equation (10) allows one to use *output price* inflation and TFP growth at the economy-wide level as an indirect measure of the rate of *input price* inflation at the aggregate level. Solving for  $dw_a$  in Equation (10) and substituting it into Equation (9) for  $dw_i$  yields the second version of the price cap:

$$(11) \quad dp_m = dp_a - x \quad \text{where } x = dTFP_i - dTFP_a$$

Equation (11) states that output prices be allowed to change at the rate of aggregate (output price) inflation minus an adjustment factor that represents the *differential* between the target and economy-wide rates of TFP growth. This formulation dispenses entirely with the need to compute a separate input price index and preserves the important incentive features. The Commission uses this price cap

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<sup>1</sup> The required assumption for this to hold at the economy-wide level is the ratio of supernormal profits to GNP is (roughly) constant. This assumption has wide currency in the economics literature and empirical support from studies of income shares in the U.S. economy and estimates of the rate of profit on capital. Also note that Equation (10) implies that output price inflation should be negatively correlated with TFP growth (holding constant the rate of input price inflation). There is supporting empirical evidence. The correlation coefficient between the rates of change in the GNPPI and TFP for the domestic private economy (from the Bureau of Labor Statistics) for the period 1960-1987 is -0.67.

formulation for interexchange and local exchange carriers. The primary practical difficulty is how to determine the appropriate x-factor. The Commission relied upon studies of TFP for the telecommunications industry as the yardstick for common carriers, and then adjusted for economy-wide TFP to obtain the differential "x-factor." In MM 92-266, the Commission provisionally adopted this form of price cap for monopoly cable systems, but has not yet resolved determination of the x-factor.

**Version 3.** The structure of the cable industry makes it possible to use an even simpler, and more easily implementable, form of the price cap. As discussed in the text, the most natural and appropriate procedure is to use competitive cable systems as the yardstick for monopoly cable operators.<sup>2</sup> Letting the subscript "c" denote competitive cable systems, and using Equation (9), we get:

$$(12) \quad dp_m = dw_c - dTFP_c$$

But for competitive systems, the right hand side of Equation (12) is simply the rate of change in competitive cable prices,  $dp_c$ . Hence,

$$(13) \quad dp_m = dp_c$$

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<sup>2</sup> For this purpose, competitive cable systems can be defined according to the criteria specified by the Cable Act of 1992, excluding low penetration systems. This and other implementation issues are discussed in Section 3 in the text.



This is my recommended price cap formulation. It is extremely simple: the price change for monopoly cable systems is limited by the price change in competitive cable areas, information which is easily collected. It is important to emphasize that all three versions of the price cap presented here are based on identical economic principles. What makes the particularly simple formulation given in Equation (13) possible for the cable industry is the fact that unregulated competitive systems coexist with regulated monopoly systems in the same industry, and hence can usefully serve as the yardstick both for growth in input prices and TFP.

If the Commission judges that achievable TFP growth for monopoly cable systems differs systematically from competitive systems (e.g., because of demonstrable differences in plant age, technology, population density etc.), the price cap in Equation (13) can be amended to capture this structural difference. The modified form is:

$$(14) \quad dp_m = dp_c - [dTFP_m - dTFP_c]$$

In principle, the bracketed productivity adjustment factor in Equation (14) could be either positive or negative. In any event, this modification should only be adopted if there is substantial evidence of a systematic difference in TFP growth between monopoly and competitive systems.